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A RESEARCH PROGRAM TO IMPROVE TECHNIQUES OF COMBAT COMMUNICATIO--ETC(U)
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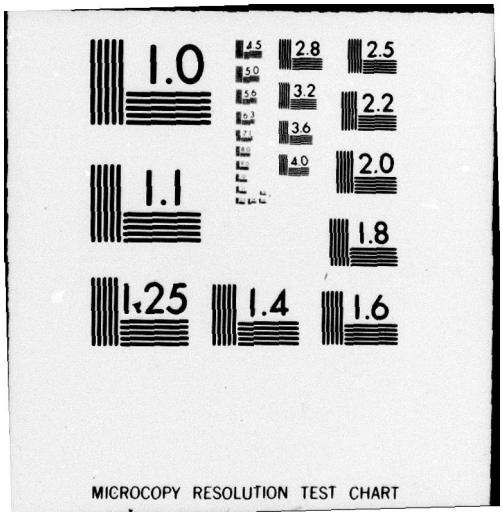
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A RESEARCH PROGRAM TO IMPROVE TECHNIQUES OF COMBAT COMMUNICATION

February 1966

U. S. ARMY PERSONNEL RESEARCH OFFICE

Army Project Number
2J024701A722

Combat Communications

(14) APRO- Research Study-66-1

(6) A RESEARCH PROGRAM TO IMPROVE TECHNIQUES OF COMBAT COMMUNICATION

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A RESEARCH PROGRAM TO IMPROVE TECHNIQUES OF COMBAT COMMUNICATION

BRIEF

Requirement:

To effect improvements in tactical voice and code communications leading to increased transfer of information, improved extraction of information from communications media, and enhanced techniques for tactical electronic countermeasures.

Procedure:

Specialized equipment for research on narrow-band filtering and instrumentation for research on two-ear (stereo) listening has been installed in U. S. APRO's Communications Research Laboratory and checked out by use in exploratory data collection.

Task effort has been organized into three subtasks each primarily concerned with one of the three aspects of any communications system--signal, operator, message:

Subtask a. Enhancement of message intelligibility through the processing of signal-noise complexes.

Subtask b. Development of improved work methods for message transmission, reception, and transcription.

Subtask c. Development of special communications languages.

Accomplishments and Implications:

In an initial study of work methods for information extraction from voice communications, some improvement in transcription was attained when the operator re-listened to the message, provided he re-transcribed it. Improvement was sufficient to warrant listening to and transcribing a message a second time, and perhaps even a third time, when reception conditions are below the marginal level of channel operations.

A study of the ability of transcribers to rate their own performance in receiving and transcribing messages embedded in noise showed considerable correspondence between high ratings and the accuracy and completeness of the message. If accurate probability values can be assigned a message, the information filtering through command chains becomes more meaningful to decision makers.

A RESEARCH PROGRAM TO IMPROVE TECHNIQUES OF COMBAT COMMUNICATIONS

PROGRAM OBJECTIVES

Despite advances in equipment technology in the communications field, voice communications will continue to play a major role in military operations over the foreseeable future. Even sophisticated transmission techniques are in many cases designed to yield a speech output, from which a listener is required to extract information.

Rarely is the transmission of high quality--most military systems, in fact, preclude a high quality of transmission by introducing severe bandwidth restrictions on the signal. As a consequence, communications are generally the weakest link in an operational system, and a considerable quantity of intelligence is lost.

Balancing the negative aspects of operational communications are two major factors: First, the human being is the most efficient device known for processing complex acoustic signals. Second, because of the high semantic redundancy of speech in most operational situations, the speech signal is a highly efficient means of transferring information under less than optimal conditions. To take full advantage of these factors, it is necessary that an operator perform at maximal efficiency. Any improvement in the ability of an operator to extract and process information from speech signals will lead to improvement in the overall transfer of operational intelligence.

The overall goal of the COMBAT COMMUNICATIONS Task of the U. S. Army Personnel Research Office is to improve performance of communications operators in an operational environment. The original requirements for human factors studies in this area stemmed from operational problems encountered by the U. S. Army Security Agency, which was especially interested in transcription operations. It soon became evident that these and other related problems were general to most communications operations. These problems were of sufficient generality and scope to form the basis for organization of the present COMBAT COMMUNICATIONS Task which was established at the beginning of FY 1965. Sponsorship of the new Task was provided by the Chief of Research and Development and the U. S. Army Security Agency.

RESEARCH APPROACH

The research orientation of the Task is based on the premise that information is presented to an operator by means of an auditory signal and that the operator's efficiency in extracting information from this signal can be improved. Whereas some of the research findings from the Task may have implications for equipment design, in no way is Task research directed toward design or development of equipment. Experimentation begins with the stimuli--the speech signals--directly as presented from the output of a communications receiver, and any experimental variations are introduced subsequent to receipt of this output.

Given the communications situation as described, the Task was divided into three subtasks. These subtasks cover the three aspects of any communication situation in which an operator is involved--the signal, the operator himself, and the message.

Subtask a. Enhancement of message intelligibility through the processing of signal-noise complexes. The goal is enhancement of operator performance by physical manipulation of the signal prior to presenting it to the operator. The research seeks to take advantage of the unique manner in which the human auditory system processes information. Research studies under this subtask are designed to secure data on maximum utilization of two-ear (stereo) listening by presenting slightly different aspects of the same signal to the two ears. Also under investigation is the extent to which intelligibility can be improved by removing narrow segments of masking noise from speech signals. This research takes advantage of the fact that the effect of an interfering signal extends beyond its spectral location. Published data concerning this area are equivocal.

Subtask b. Development of improved work methods for message transmission, reception, and transcription. The operator is considered as a component of a communications system, and means are studied for improving his performance as an information extractor, whatever the quality or nature of the auditory signal presented. Research is designed to investigate three areas of operator performance. The first deals with improvement of transcription operator performance by specifying pertinent variables of the transcription operation and determining their effect on performance. The second area is concerned with determining the effects of message repetition and redundancy and the effects of varying confirmation procedures on the accuracy and amount of transmitted information. The third area is research on the application of standard discrimination learning techniques to improve the performance of communications operators under conditions of severe channel interference.

Subtask c. Development of special communications languages. The purpose of this subtask is the development of communications languages which will be relatively impervious to jamming or other physical types of signal interference. The ultimate aim is to derive rules for constructing empirical natural languages for use under different operational conditions. There are two approaches to the problem. The first is to analyze error data and build up necessary vocabularies by empirically selecting those words or sounds which show resistance to the interference in question. The second approach is to analyze the physical characteristics of the language and build up vocabularies composed of those elements spectrally different from the interference.

RESEARCH RESULTS AND CURRENT EFFORT

During the past year, considerable effort has gone into securing specialized research equipment with which to conduct research under the signal processing sub-task. The required filters for study of narrow-band filtering have been received and checked out. Preliminary data indicate that removal of narrow spectral segments of speech does not cause as much loss of intelligibility as has been commonly thought. Collecting of experimental data for studies in this area is scheduled to begin in the second quarter of FY 1966. The first research effort is designed to determine if so-called equivalent frequency bands of speech are in fact equivalent, regardless of the width of the individual bands contributing to the equivalency. Equipment has also been secured for research on two-ear listening. Because of the dearth of available data in the literature and the equivocal nature of such data as exist, decision was made to defer experimentation until additional basic data are secured under an on-going APRO in-house laboratory project in which the same stereo listening equipment is used.

STUDY OF MULTIPLE TRANSCRIPTION METHODS

One study has been completed and a report published[1] dealing with transcription procedures for single communications transcribers. This was an investigation of some of the variables involved when a transcription operator replays a given message. Significant improvement was found to occur only when the operator makes some physical response to the signal, writing the message, for example. Simply re-listening to the message caused no significant improvement in performance, nor was performance improved by use of a previously prepared transcript as a reference aid.

Improvement, while rather slight (approximately 6 percent improvement in accuracy using isolated monosyllabic words as stimuli) was of such a nature that under marginal or less than marginal conditions of communication, re-listening and re-transcribing of messages is warranted.

The study left unanswered a number of questions. In the study, presentations of word lists followed each other immediately. The influence of time elapsed between transcriptions was not studied. There is some evidence that amount of improvement decreases with the passage of time. Also, effects of using more than one transcriber were not studied. Future plans call for investigation of these and other variables affecting the transcription operation.

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[1] Stichman, E. P., and Renaud, G. E. Information extraction from voice communications: Work methods for single transcribers. USAPRO Technical Research Note 154. June 1965.

STUDIES OF TRANSCRIBERS' RATINGS OF THE MESSAGES THEY TRANSCRIBE

A study was completed [2] in which experimental subjects rated their confidence in the accuracy of their transcripts, using a five-point scale ranging from "complete confidence" to "complete lack of confidence." Preliminary analysis of the data indicates that relatively untrained operators are moderately successful in rating their own performance in receiving and transcribing messages embedded in noise. Regardless of reception conditions, whenever a message was rated as having been received with a high degree of correctness, probability of its being correct was higher than when a lower confidence rating was given. With these relatively untrained operators, however, absolute performance appears to be a function of signal-to-noise ratio; the lower the signal-to-noise ratio, the poorer the performance. At low noise levels, messages in which operators expressed "complete confidence" in being correct were found to be about 80 percent correct, as opposed to about 45 percent correct at high noise levels. Corresponding figures for "complete lack of confidence" in being correct were 25 and 5 percent correct.

Whereas these figures indicate something less than outstanding concordance between operators' behavior and their ability to describe that behavior, there are fragmentary data indicating that experienced operators are much more efficient in evaluating their own behavior.

Data of this nature are of considerable value in a number of operational situations. Many decisions depend on an evaluation of the accuracy and completeness of a message. If decision makers can evaluate the probable "goodness" of a transscript, or of portions of a transcript, more rational decisions can be made and considerable time can be saved in determining whether a re-transcription is necessary. In addition, information filtering through command chains becomes more meaningful if accurate probability values can be assigned at each step of the filtering process.

Related research planned for future phases of the program includes studies of the effects of operator proficiency on ability to rate transcriptions, as well as of the effects of other variables such as rating scale, effect of feedback on operator performance, and effect of ratings on subsequent levels of information extraction.

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[2] Report presently in preparation for publication as an APRO Technical Research Note.

REFERENCES

Additional USAPRO Publications Dealing wtih Research
of The COMBAT COMMUNICATIONS Task

Castelnovo, A. E., Tiedemann, J. G., and Dobbins, D. A. Performance of single vs multiple voice radio transcribers working under three speech-to-noise ratios. Technical Research Note 135. September 1963.

Castelnovo, A. E., Tiedemann, J. G., and Skordahl, D. M. Individual differences in transcribing voice radio messages embedded in atmospheric noise. Technical Research Note 137. October 1963.